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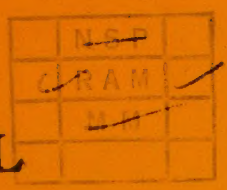

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Mr. F. H. GRIFFITH, M.P., J.P., U.M.

We have to record with deep regret the death of Mr. F. H. Griffith, who was actively connected with the Institute for more than two decades.

Mr. Griffith was nominated to the Board as a representative of the Planters' Association of Ceylon on 5th December, 1930, and remained a member until his retirement from Ceylon in October 1951. During this period he served as Chairman of the Experimental Committee from 17th July, 1940, and as Chairman of the Board from 1st June, 1950, until retirement. He was also Chairman of the Kalutara District Planters' Association.

Mr. Griffith was one of Ceylon's pioneer planters who took an active interest in the rubber plantation industry and in research connected therewith. The Industry and the Institute in particular will always remember him with gratitude.

W. P. H. D.

NOTICES

DARTONFIELD GROUP—VISITORS' DAY

Those who wish to visit the Institute are requested to do so after making an appointment. No special days are set apart as Visitors' Days and the services of the technical officers can be availed of for discussion or demonstration only by prior appointment.

PUBLICATIONS

Rubber Research Institute publications comprising Annual Reports, Quarterly Journals and occasional Bulletins and Advisory Circulars are available without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of rubber estates in Ceylon over 30 acres in extent. Advisory Circulars and Smallholdings Leaflets in English or Sinhalese will be available without charge to smallholders on application. Forms of application can be supplied on request.

It will be appreciated if subscribers will return any back publications which are of no use to them.

ADVISORY CIRCULARS

The undernoted Advisory Circulars may be obtained on application at 30 cents per copy. Future issues in the series will be sent free of charge to estates and smallholders registered for the receipt of our publications :—

(5) Straining box for latex (January, 1940).

(12) Warm Air Drying House for Crepe Rubber (Reprinted 1952).

(33) Mechanical Felling of Rubber Trees (Reprinted March, 1955).

(37A) Manuring—Magnesium Deficiencies in Rubber (July, 1954).

(37B) Potassium Deficiencies (September, 1954).

(38) Planting and After-Care of Budded Stumps and Stumped Budgrafts (Superseding Advisory Circular No. 8) (March, 1953).

(39) Clonal Seed as Planting Material (Superseding Advisory Circulars No. 26 and 27) (July, 1953).

(40) Tapping of Hevea Rubber (Superseding Advisory Circulars No. 17 and 34) (June, 1954).

(41) Pink Disease (June, 1954).

(42A) New Local Planting Material for Small Scale Trials on Estates (July, 1955).

(43) Oidium Leaf Disease (Superseding Advisory Circulars No. 22 and 28) (June, 1954).

(44) Diplodia Dieback and Collar Rot of Hevea and Blue Spot of Crepe Rubber (June, 1954).

(47) Ustulina Rot of Rubber Trees (November, 1954).

(49) Root Disease in Replanted Areas (Superseding Advisory Circular No. 31) (October, 1951).

(50) Orange Gall of Hevea (December, 1954).

(51) Bird's Eye Leaf Spot of Hevea (December, 1954).

(52) A Guide to the Cost of Replanting Rubber (December, 1954).

(56) Cover Crops (Superseding Advisory Circular No. 25 (October, 1955).

(57) Notes on Rubber Seedling Nurseries (Superseding Advisory Circular No. 35) (October, 1955).

(58) Notes on Budgrafting Procedure (Superseding Advisory Circular No. 1) (December, 1955).

(60) Sale of Budwood (Superseding Advisory Circular No. 42) (June, 1958).

(61) Prevention of Coagulation in the Field (Superseding Advisory Circular No. 53) (September, 1958).

(62) The White Root Disease of Hevea—Fomes Lignosus (Superseding Advisory Circular No. 46) (October, 1958).

(63) Brown Root Disease of Hevea—Fomes Noxius (Superseding Advisory) Circular No. 48) (December, 1958).

(64) Bark Rot and Canker of Hevea—Phytophthora Palmivora (Superseding Advisory Circular No. 54) (December, 1958).

(65) The Phytophthora Leaf Disease of Hevea—Phytophthora Palmivora (Superseding Advisory Circular No. 45) (December, 1958).

(66) Manuring of Rubber (Superseding Advisory Circulars No. 59 & 59A) (April, 1959).

A Note on Guatemala Grass as Mulch for Rubber Plants

By

E. D. C. Baptiste and A. J. Jeevaratnam

The advantages of mulching, or "thatching," in Agriculture have been known from early times.

The main advantages claimed for mulching are:

(*a*) the addition of organic matter and readily available nutrients to the soil, thus improving the soil structure and fertility.
(*b*) The conservation of soil moisture during periods of dry weather by restricting evaporation, the soil remaining cool and moist under an effective mulch and providing a favourable medium for the superficial development of feeding roots of the main crop.
(*c*) The cushioning effect on rain drops in regions of high and intense rainfall, reducing the incidence of soil erosion.
(*d*) The suppression of weeds under a layer of mulch.

Experiments comparing several types of cover plants as mulching material have shown conclusively the advantages of a mulch in the first few years of a rubber plantation, but the main drawback under estate conditions has been the lack of sufficient mulching material close at hand for the initial mulching operation and for replenishing the mulch layer at suitable intervals.

In recent years certain rubber estates have adopted the practice of growing Guatemala grass between the rows of young rubber plants and using the loppings of this grass at suitable intervals for mulching the ground along the clean weeded strips or circles of the planting rows, with an undoubted beneficial effect on the growth of the rubber plants.

Description:

Guatemala grass (*Tripsacum laxum Nash*) is a native of Central America. It was introduced from the Philippines in 1926 for cultivation as a fodder crop in Ceylon. It is a perennial with long, dark green and slightly hairy leaves. The culms are erect and the grass may attain a height of 5 to 8 feet, producing a dense mass of herbage. It grows well under different conditions of soil and rainfall, and is drought resistant. The grass is able to withstand three or four loppings a year and may be eradicated by a single cutting at ground level without any disturbance of the soil, a fact of importance on steep land characteristic of most of the rubber and tea estates in this country.

Spacing in Multiplication Nursery:

This may vary from $1\frac{1}{2}' \times 1'$ to $3' \times 2\frac{1}{2}'$. At the wider spacing it is desirable to plant two sets per point to establish a good stand. At a spacing of $2\frac{1}{2}' \times 2'$

and planting two sets per point, a total of 16,000 stem cuttings would be required to plant one acre of Guatemala grass.

It has been estimated that 1,000 four-node stem cuttings can be obtained from 1/100th of an acre planted with Guatemala grass at a spacing of $2\frac{1}{2}' \times 2'$.

Propagation.

Stem cuttings with about four nodes planted at an angle of 40° to 50° to the ground have given excellent results.

It is best to plant the stem cuttings early in the wet season. Inter-cultivation soon after planting may control weed growth and, by loosening the soil, increase tillering propensity. In Trinidad, where Guatemala grass is grown as a fodder crop, it has been found that an application of Sulphate of Ammonia at the rate of one cwt. per acre after each cut helps to maintain high grass yields. In Ceylon the Tea Research Institute recommends the application of a fertilizer mixture of the following composition:—

Sulphate of Ammonia (20.6% N)	—	5 parts by weight
Rock Phosphate (28.5% P_2O_5)	—	$2\frac{1}{2}$ parts by weight
Muriate of Potash (60% K_2O)	—	$1\frac{1}{2}$ parts by weight

When the loppings are allowed to decay in the same area as they are grown, the level of manuring will depend on the desire to build up soil fertility. Applications of Sulphate of Ammonia at 1 cwt. per acre or the above fertilizer mixture at 2 cwts. per acre, may be sufficient.

If the grass is cultivated intensively in one area and loppings transported to thatch other areas it would be wise to manure with the above NPK mixture at the rate of 4 cwts. per acre. The fertilizer is conveniently applied soon after each harvest.

Harvesting and Yields:

The yield of Guatemala grass has been found to bear a direct relation to the amount of water available during the growing period of the grass.

The greatest yield of protein per acre is obtained when the grass is cut after about eight weeks' growth, but since the growth and composition depend on the rainfall there cannot be a hard and fast rule.

During the wet season a cutting cycle of 50-60 days may seem desirable but this can be varied depending on growth. It has been reported that regeneration of the grass after cutting is quicker if the cutting is done at about 8 to 9 inches from ground level, high enough to miss the growing point of the stem. Once a year (at the onset of the rainy season) cutting may be done at 2 to 3 inches *below* the growing point so as to stimulate fresh growth from new buds rather than from old culms.

In newly established plantings of this grass the first cuts may be made at this low level in order to obtain larger clumps.

Average yields of 35 to 45 tons of herbage per acre have been reported from the West Indies.

Guatemala grass has the following advantages as a source of mulching material:-

(*a*) The quantity of herbage produced is voluminous.

(*b*) The yield in terms of dry weight is high. It has been estimated that nearly 20 tons of dry matter, from about 120 tons of the fresh aerial parts of Guatemala grass, can be obtained from one acre during the third year of growth of a rubber planting in the Kalutara district.

(*c*) The aerial portions used as mulch are a rich source of easily decomposable organic residues if cut at the proper stage of growth, and they do not regenerate when used as mulching material.

(*d*) The nutrient content of the herbage compares favourably with that of leguminous cover plants. Samples of the aerial portions of the grass analysed at this Institute showed the following composition, expressed as a percentage of dry matter:

		%	S.E.
Nitrogen	... ...	0.73	0.05
Phosphorus	... ...	0.07	0.01
Potassium	... ...	1.69	0.28
Calcium	... ...	0.17	0.02
Magnesium	... ...	0.22	0.02

(*e*) Guatemala grass is deep rooted and produces a considerable amount of adventitious roots.

According to Haworth (1) the root distribution of the grass on old tea land after $2\frac{1}{4}$ years under Guatemala grass was found to be as follows:—

Depth	0–6″	6″–12″	12″–18″	18″–24″	24″–30″	30″–36″	3′–10′	Total
Dry roots tons/acre	5.8	5.3	3.1	1.8	1.4	0.8	0.1	19.2

The figure of 5.8 tons per acre in the top six inches of soil is considerably more than that found by Haworth for other grasses (*e.g. Pennisetum purpureum* or *Axonopus compressus*) grown on similar soil.

Haworth estimated that the 20 tons dry weight of Guatemala grass roots per acre would contain approximately 224 lb. of Nitrogen, 75 lb. of Phosphorus and 600 lb. of Potassium.

The organic matter produced by the decay of the roots has, to quote Haworth, "the additional advantage of being intimately distributed throughout the soil mass in a way which it is quite impossible to achieve by mechanical incorporation."

(*f*) Guatemala grass does not seem to check or retard the growth of leguminous covers in its vicinity.

(*g*) Definite evidence has been obtained of an improvement in the structure of the soil that has carried Guatemala grass.

(*h*) Guatemala grass seeds only sparingly under Ceylon conditions, especially if cut back at regular intervals, and the spread of the plant by seed is unlikely to constitute a nuisance.

Guatemala grass in Tea Areas:

In Ceylon Guatemala grass has been grown experimentally as a fallow crop during the resting period between the uprooting of the old tea and the replanting of the new.

It seems ideally suited for this purpose since, under the conditions of high rainfall and steep land obtaining on high elevation tea estates, its removal by cutting back to ground level, which has been found to kill out more than 90 per cent of the grass stools, may be done without any disturbance to the soil.

Guatemala grass in Rubber Areas:

It has been found practicable to grow the grass between the rows of rubber plants in the early years to provide a readily available supply of suitable mulching material from inside the rubber planting for use along and around the rubber plants.

It is important, however, that the Guatemala grass is not planted too near the rubber plants so that it does not compete with the latter for water and nutrients. Guatemala grass may not be planted within 5 feet of the rubber plants.

The avenue system of planting is well suited to this inter-cultivation which is clearly shown in Figure 1 of a 3-year old replanting of clone PB 86 on an avenue system of 40′ × 6′.

Fig. 1.—Interplanting of Hevea and Guatemala grass

In this replanting Guatemala grass is grown in seven rows spaced 5′ apart from each other and from the rubber rows and was originally planted 2′ apart along each row. The grass is cut back three times a year to provide the material for mulching along the weeded strips of the rubber rows. The rate of girthing of the budded trees in this replanting averaged 4 inches a year.

In another replanting of the same estate with planting distances of 35′ × 8′, three rows of Guatemala grass planted 3′ apart in 9′ wide strips along the centre of two rubber rows produced about one pound of green matter per square foot of

the planted area in the third year from planting. This is equivalent to about 100 grams dry matter per square foot once in four months.

A close-up of the mulched planting rows in a May-June 1954 replanting of Tjir 1 seedlings is shown in Figure 2, and Figure 3 provides a bird's eye view of the prolific development of feeding roots of Hevea on the surface of the soil just below the decaying mulch, which has been carefully removed to expose the roots.

Fig. 2.—Guatemala grass mulch along Hevea planting rows

Fig. 3.—Profuse root growth under Guatemala grass mulch

The prolific growth of feeding roots, shown in Figure 3, is ample evidence of the ideal conditions provided by the Guatemala grass mulch and it is the accepted practice on this particular estate to broadcast fertilizer over the mulched strips twice a year and then cover up the applied fertilizer with a fresh layer of the mulching material.

This method of applying the fertilizer on the actual spot which shows the greatest development of feeding roots is clearly sound agricultural practice and it is indeed hardly surprising that the majority of the seedlings of clone Tjir 1 shown in Figure 2 had reached a girth of 20 inches at 3 feet from the ground at the early age of $4\frac{1}{2}$ years from planting.

There is little doubt, therefore, that the rate of girthing in this replanting has been increased by mulching.

We would generally recommend cutting back of the grass and mulching along the planting rows with the loppings at the onset of regular dry periods. This procedure will minimize loss of water due to transpiration from the grass foliage and to evaporation from the cleared strips along the planting rows.

Apart from the effect of mulching in promoting profuse root development by providing favourable conditions of temperature and moisture of the soil, in addition to increasing the nutrient status of the soil and reducing soil erosion, the effect of these factors on the microbiological activity in the soil hardly needs special mention.

It has been claimed that the rubber roots can function as a facultative saprophyte, *i.e.* that they can feed directly on decaying organic matter. It is interesting in this connexion to note that the first observation of the symbiotic association of Hevea roots with a fungus (mycorrhiza) was made in Ceylon in 1928 by Malcolm Park (2) working at Peradeniya Gardens. This observation was confirmed ten years later by Dutch workers (3) in Sumatra who demonstrated an intimate relationship (endotrophic mycorrhiza) in which the fungus actually penetrates the cells of small superficial feeding roots of Hevea which are in direct contact with raw humus produced from leaf debris from both the rubber and the ground cover.

This ability of rubber plants to form mycorrhiza may be an important factor in their nutrition and, if this is actually the case, the extra organic matter provided by the Guatemala grass mulch would play an important part in the early growth of the rubber plants.

Acknowledgements :

We are indebted to Mr. L. C. de Mel, Manager of Panadura Tea and Rubber Company Ltd., for permission to reproduce in this article the photographs taken by the senior author in March 1958.

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1. Haworth, F. (1953). Tropical Agriculture Vol. XXX.

2. Park, Malcolm (1928). The Tropical Agriculturist Vol. LXX.

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Influence of Factory Water on the Quality of Rubber

By

K. F. Heinisch

Introduction:

At present natural rubber is commercially graded on the basis of the visual appearance and this is usually influenced by factors such as colour, texture and visible contaminations. As the quality of 'factory' water used during the manufacture of natural rubber has a very great effect on these factors, as well as on the intrinsic properties of the final product, it is most appropriate to discuss in some detail this subject which is generally overlooked.

For the manufacture of rubber a considerable quantity of water is required. The total water consumption per kilogram of rubber should be estimated at 30–50 litres for sheet and 60–80 litres for crepe. This water is required for dilution of the latex, preparation of solutions of chemicals, rinsing on the rolls, leaching, cleaning, cooling the engines, etc. The quality requirements of the water used at various stages of manufacture are different but in practice these have not yet been expressed precisely and opinions on this subject may differ considerably. Generally, it is only stated that pure clean water is required, which should be without colour and bad smell and should not contain too high a concentration of salts, especially those of iron, manganese and calcium. There is, however, no objection if the water used for rinsing and cleaning is slightly coloured or opalescent, but it should be free of suspended matter.

Requirements:

In a recent publication (1) from the Research Institute of the Sumatra Planters' Association (formerly "General Experiment Station of the A.V.R.O.S.") a formulation of the quality requirements with suggested maximum limits has been given based on several years of practical experience.

The standards, as applied by the above mentioned Institute and with which the R.R.I.C. can agree, are as follows:—

Iron	1 mg/litre for crepe 3 mg/litre for sheet
Copper	0.5 mg/litre
Manganese	0.5 mg/litre
Permanganate value	20 mg/litre
Lime content	50 mg/litre
Bicarbonate	300 mg/litre
Hardness	6°D
Floating dirt	10 mg/litre, smaller than 325 mesh
pH	5.8—8

The above specifications are not to be considered as fixed upper limits but rather as a general guide. Only after a full analysis and a study of the local conditions will it be possible to assess the quality of the water. The choice of water is

generally restricted and the composition, dependent on the place of origin and the season, may vary to a great extent so that the above requirements cannot be fulfilled even after chemical treatment. Hence under such conditions some concessions have to be allowed.

Sources of water supply:

The different types of water which may be available on estates, classified according to their respective sources are as follows:—

(1) *Artesian water*, from aqueous layers, sometimes up to 900 feet deep, obtained by boring shafts which go through impermeable layers to the water layer. This type of water is clean, free of micro-organisms and has usually little or no impurities other than sand. Dependent on the geological structure of the underground, artesian water may, however, contain a high concentration of iron, manganese, bicarbonate, sulphur, calcium or may be too hot for immediate use.

Well water, from subterranean streams which penetrate to the surface at certain points. If not contaminated by contact with soil water and surface water it has usually the same properties as artesian water.

Soil water, penetrating surface water which collects on water-impermeable layers and forms a stagnant water horizon. Such water is mostly contaminated with organic and inorganic matter.

Running Surface water from rivers and streams contains floating dirt. However it must be pointed out that the extent of the impurities depends on seasonal circumstances and that a river with muddy water in rainy weather may in the dry season have a very clear water which may be used without any treatment.

Standing Surface water from lakes and swamps is normally contaminated with floating dirt and has sometimes a high content of different salts.

Brackish water, a mixture of river and sea water at the mouth of rivers.

Content of iron:

It may often be observed that apparently clear water which is allowed to settle for several hours in a container shows a reddish-brown colouration and precipitation. This precipitation is caused by iron which, in most cases, is dissolved in the water as ferrous bicarbonate and this is precipitated as ferric hydroxide in the form of a brown voluminous mass by contact with air according to the reaction:—

$$4\ Fe(HCO_3)_2 + O_2 + 2H_2O \rightarrow 4\ Fe(OH)_3 + 8CO_2$$

or, if the dissolved iron is in the form of sulphate the following reaction takes place:—

$$4\ FeSO_4 + O_2 + 10\ H_2O \rightarrow 4\ Fe(OH)_3 + 4\ H_2SO_4.$$

Primarily the ferric hydroxide is formed as a sol in the colloidal state. This formation is a hydrolytic process dependent upon the pH. For water with a pH lower than 7 this reaction either does not take place or takes place very slowly. The second stage, the conversion into the insoluble sol, needs a slight alkaline reaction and this is facilitated by the presence of carbonates and by contact with the already precipitated ferric hydroxide. If, in a few cases, iron is present mainly as ferrous sulphate, lime or caustic soda is essential for the conversion into insoluble ferric hydroxide. Artificial aeration by spraying through nozzles or by splashing over weirs, cascades or granulated materials increases the effect and speed of precipitation.

If iron-containing water is mixed with latex the precipitations take place and red-brown spots resembling fungi are often observed in crepe rubber. In contrast to rust particles from the water pipes these spots do not have the same characteristic shape.

It has been stated by several workers that iron has a relatively harmless effect on the intrinsic properties of rubber when compared with copper and manganese. However it must be borne in mind that under certain circumstances a mutual activating effect between manganese and iron may appear, of which not much is yet known. For this reason no limits of the iron content in rubber have been fixed by the Rubber Manufacturers' Association of New York.

The maximum quantity of iron allowed for water is 1 mg/litre for crepe and 3 mg/litre for smoked sheet and these limits are only based on the influence of the iron on the appearance of the rubber. Long experience has shown that it does not seem to be possible to manufacture a reasonable white or spotless crepe if the iron content of the water is higher than approximately 1 mg/litre. The effect of discolouration may be increased if a high iron content is linked with too high a permanganate value. The problem is less urgent with sheet manufacture as the discolourations are masked by the colour of the sheets, and therefore there is no objection to a higher concentration. It must be pointed out, however, that flakes of iron hydroxide may cause visible spots when the sheets are examined against the light.

Too high a content of soluble iron salts, combined with humic acids, phosphoric and other organic and inorganic acids which will not precipitate by contact with air, is undesirable. It produces a darker, dull colour of the crepe and may cause shiny spots on sheets. It has been observed that even soluble complex bound iron in a concentration exceeding 0.1 mg/litre may be transformed into an insoluble form by the very common iron bacteria, such as the round shaped *Siderocapsa Treubii*, the long shaped *Crenothrix polyspora*, *Gallionella ferruginea*, *Clenothrix fusa* and *Chlamydothrix ochracea*. The latter ones consist of long colourless cylindrical cells surrounded by a transparent sheath. Dissolved iron and manganese compounds are oxidized by these bacteria and are deposited as insoluble compounds in the flexible sheath. These bacteria are very common and grow frequently in water pipes, containers, etc. Under favourable circumstances they may develop so prolifically that large mucous clusters may come out of the pipes or the pipes may even be clogged.

Purification of water containing organic iron compounds (swamp water) is difficult and involves extra costs so that in such cases the possibility of another water supply should be considered. Special attention should also be paid to the fact, that by using RPA 3 (Emulsion A) as bleaching agent small amounts of iron in the water, far below the limit, may have a detrimental effect on the colour and are probably one of the main causes for the greyish or reddish discolouration of the bleached crepe.

It has been observed that there are fewer difficulties with discolouration of crepe by iron salts by using oxalic acid as coagulant instead of formic acid.

Copper and Manganese:

Because of the harmful effect of very small amounts of copper and manganese on the durability of rubber, the Rubber Manufacturers' Association of New York has fixed maximum limits. By drafting the standards for water used in the manufacture of rubber a reasonable safety margin was therefore taken into account. While copper impurities mainly originate from compounding materials and manu-

facturing chemicals, the manganese generally appear to be in the water. A high manganese content of the water is almost always linked with too high an iron content. As manganese shows a similar reaction to iron both salts may, in most cases, be removed together by aeration.

Permanganate value:

The permanganate value of water, expressed as mg. potassium permanganate per litre, is generally taken as giving an indication of oxidizable organic matter. Water with a high content of organic matter is always heavily infected by micro-organisms, while this organic matter itself creates a favourable environment for further development of fungal and bacterial growth resulting in pronounced discolouration of crepe rubber and the appearance of spots with a full range of colours.

The degree of development of micro-organisms generally depend on a series of factors, amongst which are the degree of infection, nutritive substances, moisture content of rubber and air, drying conditions ,etc. Mould can develop on any type of rubber if the conditions are suitable. The infection does not, however, manifest itself until the rubber is in a half dry or dry condition and at this stage it is difficult to remove it.

Stains of various colours, from light yellow to black, may originate on crepe by the action of micro-organisms.

Apart from the degree of infection and the substratum, the humidity and temperature of the environment and the moisture content of the rubber have an influence on the development of mould. It has been found that at a relative humidity below approximately 75% and a moisture content of the rubber below approximately 0.8% no growth of fungi occurs. The intensity of development increases within the range of 21–37°C and the average optimal growth conditions are at about 37°C. (5) It appears that the discolouration is linked with an increase in magnesium, calcium, manganese and iron in the rubber. Generally the circumstances for the development of fungi and bacteria (especially B.prodigiosus and B.subtilis) are more favourable for crepe than for sheet, particularly by using unheated drying sheds. It is therefore necessary that, for the prevention or at least for the restriction of the appearance of fungi, the requirements of the water for the manufacture of crepe should be higher than that for sheet.

Dirt Content:

By using water with mechanical impurities these impurities will be introduced into the rubber and may cause a decrease of first quality output or may even affect the colour of crepe. Therefore dirt, including coarse organic matter of a particle size larger than 325 mesh (0.044 mm), which is taken as the standard for determination of contaminations in rubber, should be avoided. The standard has been fixed at 10 mg/litre dirt, provided it is smaller than 325 mesh.

As far as coarse impurities are concerned they may easily be removed by filtration or decantation. Water containing colloidal impurities is not so easy to purify and must first be treated with a saturated solution of alum. Besides the mechanical impurities a large amount of dissolved iron and manganese will be removed by this treatment. The amount of alum required is dependent upon the impurities in water and varies approximately between 40-100 grams/cubic metre. A large part of the colloidal alum will also be removed along with the precipitated colloidal impurities so that the remaining part will cause no harm when using this purified water for dilution of the latex.

Generally colloidal dirt has a negative electric charge so that the floating particles are repulsed. In principle the clarification means a neutralization of this electrical charge. Alum or aluminium sulphate reacts with the carbonate present in the water according to the reaction:—

$$Al_2 (SO_4)_3 + 3\ Ca\ (HCO_3)_2 \rightarrow Al_2\ (OH)_6 + 3\ Ca\ SO_4 + 6\ CO_2.$$

and forms a hydroxide sol which is slowly converted into a gel, manifesting itself as enlarging and precipitating flakes. Because of the positive electrical charge of the hydroxide sol the negatively charged dirt particles are attracted and precipitated together.

Sometimes difficulties may occur with soft water because of a lack of carbonates. In this case the reaction may be initiated by the addition of some lime or soda.

After purification the water can be filtered through an ordinary sand filter. For carrying out this purification, simple and cheap installations may be constructed on the estates.

Lime Content and Hardness:

The most common salts in water are calcium and magnesium in the form of carbonates and bicarbonates, the presence of which cause the total hardness or soap-consuming power. The temporary hardness is called that part which is destroyed by boiling the water and is due to the presence of bicarbonates. The hardness is expressed in either German (°D), or English (°E) or French (°F) grades, which means:

1°D	=	10 mg. CaO/litre as calcium or magnesium
1°E	=	10 mg. $CaCo_3$/700 ml. ,, ,,
1°F	=	10 mg. $CaCo_3$/litre ,, ,,
Therefore 1°D	=	1.25°E = 1.29°F

A high content of calcium and magnesium salts may cause precoagulation. Generally difficulties may be experienced when the concentration exceeds 50 mg. CaO per litre, but under local conditions, the use of anticoagulant and the susceptibility of the latex may be of some effect. The calcium content of water may be subject to seasonal influences. Normally it may be stated that river water has the lowest percentage of calcium and magnesium.

Bicarbonates:

Too high a content of bicarbonates may be the reason for the occurrence of gas bubbles in sheet because of the liberation of carbon dioxide. 300 mg/litre seem to be the maximum limit. However, a higher content can be tolerated in the manufacture of crepe.

If necessary the bicarbonates can be converted into practically insoluble carbonates by adding quicklime or lime water to the water concerned, or by treatment with sulphuric acid.

Conclusion:

It is necessary that water used in the manufacture of rubber meets a rather high requirement in order to avoid difficulties in manufacture and to prevent deterioration of the quality of the rubber.

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Studies on the Production of Toxins by Fomes Lignosus

I.—PRELIMINARY INVESTIGATIONS

By

O. S. Peries

"White Root Disease," causal fungus Fomes lignosus (Klot.) Heim ex. Pat., is a very serious problem that has to be contended with in rubber plantations, especially in the first five years of the life of a new plantation (1). Although the above ground symptoms of this disease are well known, the manner in which the fungus induces the typical host responses has not been studied recently. The assumption prevails that the symptoms produced are merely those caused by the active invasion of the root system by the fungus and the consequent interruption of food and water transport (2). This assumption too has not been clearly defined. So far as can be ascertained from the literature available on the subject, no studies have been made on the production of toxins in vitro by this fungus.

The purpose of these investigations is to find out whether this fungus produces a toxin when grown in liquid media; and if so whether that toxin has any relationship to the symptoms produced by the fungus in vivo. Napper (3) has found that the external growth of *Fomes lignosus* proceeds ahead of the region where the root is penetrated and colonized. If the fungus produces a toxin, it may also be found that it helps the fungus to kill the root tissues under the superficial growth, described by Napper, before penetration occurs.

Materials and Methods.—A culture of *Fomes lignosus* highly pathogenic to rubber was used throughout these studies. Following preliminary trials, the basal medium used for these toxin investigations was a modified Knop's solution, containing 10g/litre glucose, 1 gm/litre asparagine and 1 mgm/litre of thiamine. The chemicals used were of analytical grade, and the asparagine and thiamine were from the special "Biochemicals" manufactured by Hoffmann–La Roche Ltd., Basle, Switzerland. The pH of the medium after sterilization (20 mins. at 17.5 lb. per sq. inch pressure) was 5.0 to 5.2. The cultures were incubated at room temperature (27°C $\pm$ 2°).

The method of inoculating the flasks was that described by Riggenbach (4). Cultures were grown for at least 30 days in still culture in 500 ml. Jena glass Erlenmeyer flasks, each containing 100 ml. of the basal medium. The fungal mats were removed by filtration through cotton wool pads. The filtrate from this was refiltered through a No. 595 Schleicher and Schuell filter paper and finally passed through a bacterial filter. Streak plates were made from samples of this liquid to test it for the presence of fungi and bacteria. The culture filtrates were colourless and had a slightly musty odour. Final pH readings were between 5 and 5.3. The filtrates from sets of ten flasks were bulked for investigation.

The standard technique of employing cuttings of tomato seedlings was used to indicate the presence of phytotoxins in the filtrate and to establish the effects of various dilutions of it. The tomato plants were cut under water, and placed one per flask in the pure filtrate and in various dilutions of it with sterile distilled water. Adequate controls of cuttings dipped in sterile distilled water and in sterile basal medium were maintained. Observations were made at regular intervals for 96 hours. The symptoms looked for were wilting, curling, chlorosis, and necrosis of the living tissues.

Preliminary attempts have been made to ascertain the nature of the toxins involved by fractional precipitation followed by analysis. Observations have also been made on the reaction of the toxin to heat.

Results.—The response of cuttings of tomato plants when placed in culture filtrates of *Fomes lignosus* was a gradual curling followed by the appearance of necrotic spots on the leaves. There was a definite sequence in the appearance of the necrotic spots, the lower leaves being affected first, followed by the upper younger leaves. A striking fact was that there was no wilting of the cuttings at any stage, the stem and leaves being quite turgid up to the time of collapse through death. The cuttings placed in the controls remained normal throughout the period of observation.

In the case of cuttings placed in the filtrates from 30-day-old cultures, the symptoms appeared after approximately 60 hours from the time of dipping. Symptom expression occurred within 6 hours of dipping in culture filtrates from 44-day-old cultures.

It has also been noted that the symptoms of curling and necrosis appeared more rapidly when the cuttings dipped in the filtrates, irrespective of the age of the culture from which they were obtained, were placed in direct sunlight.

The toxin produced by *Fomes lignosus* in liquid media, was found to be thermostable when heated at 100°C for 10 minutes. In fact heating seems to enhance the toxicity of the filtrate as it hastens the process of symptom expression. Nelson (5) has also described a toxin, produced in vitro, the toxicity of which increases on heating the filtrate.

Histology.—Free hand sections of tomato stem tissues from cuttings dipped in culture filtrates showed no discolouration of the vascular tissue. No abnormalities such as the formation of tyloses or the plugging of xylem vessels with gummy substances were observed.

Discussion.—The results of the investigations carried out so far indicate that *Fomes lignosus* produces a toxin when grown in liquid culture media. Unlike the toxins produced by many other fungi studied, the toxin produced by *Fomes lignosus* does not cause wilt or chlorosis, but only a curling of the leaves followed by the appearance of necrotic spots on them.

It has been found that the older the culture from which the filtrate is obtained, the more rapid is the appearance of the necrotic symptoms on tomato cuttings dipped in it. This may mean that the concentration of the toxin increased with increasing age of the culture, or that the toxin is produced by the fungus only on "ageing" in culture. This can be verified after the toxin is isolated or when a method of estimating the concentration of the toxin in culture filtrates is perfected. Gaumann (6) has stated that toxins are usually produced in vitro, only after the sugars in the nutrient solution in which growth takes place have been exhausted. Although this aspect of toxin production by *Fomes lignosus* has not yet been studied, it may well be that the toxin is produced in vitro as a result of autolysis, after the sugars are utilized.

DIAGRAM (A)

Effects of culture filtrates of *F. lignosus* on tomato cuttings.

Left: Cutting in culture filtrate after 24 hours. This shows curling and necrotic spotting. The lower leaves are dead.

Right: Cutting in distilled water.

DIAGRAM (B)

Effects of culture filtrates of *F. lignosus* on tomato cuttings.

Left to right Healthy leaf and leaves of cuttings 6 hours, 18 hours & 24 hours respectively, after dipping in culture filtrates of *F. lignosus*.

The quickening of the process of symptom expression in direct sunlight may be due to one of two causes (*a*) increased transpiration in direct sunlight enabling the toxin, which is presumably carried in the transpiration current, to reach the foci at which symptom expression occurs faster; or (*b*) due to the activation of the toxin in strong light. Nelson (5) has also made reference to the light activation of a toxin produced in vitro.

It is not possible at this stage to characterize the toxin produced by *Fomes lignosus* in vitro, from the preliminary work reported here. It has not been possible to obtain a precipitate by the addition of protein precipitants to the culture filtrates. Too much significance cannot be attributed to this, however, as the work done so far on this subject has been very limited. Additional tests are, therefore, required to determine the nature of the toxin concerned.

Further studies concerned with the properties, characteristics and nature of this toxin, as well as its effects on rubber seedlings, are in progress.

Summary.—Production of a thermostable toxin by *Fomes lignosus* in vitro has been observed. Some of the characteristics of the toxin are discussed.

Acknowledgements:

The author gratefully acknowledges the assistance received from the following members of the Plant Pathology Department staff:— Messrs. *H. L. Munasinghe, E. G. Mendis, T. M. Fernando and S. K. Samaraweera.*

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Planting Topics

DOUBLE-CUT TAPPING SYSTEMS WITH BUDDED RUBBER FOR ECONOMIC YIELDS

For many years the "Double-Three" system of tapping, expressed in the nomenclature of the International Notation System as 2S/2, d/3, 133%, was considered as a form of high intensity tapping.

The double-three system was tried out on both old seedling and budded rubber during the last World War, when Ceylon was expected to attain maximum production as a war effort.

Fourteen to fifteen year old budded trees in the Institute's Nivitigalakele Estate, made up of local clones, were tapped on 2S/2, d/3, 133%. This rubber which was yielding approximately 450 lb. dry rubber per acre per year on S/2, d/2, 100% reached an increased yield of 1,100 lb. per acre per year in the third year of tapping on the double-three system.

Moderately high yielding clones like PB 25 and AVROS 256 at Dartonfield Estate, initially tapped on a reduced intensity of 67%, showed increased yields of about 160 per cent over the control standard system of S/2, d/2, 100% under comparable conditions. These budded trees were about 9 years of age, when the double-three tapping system was introduced. The increased yields were down to 30 per cent, compared with the control, in the fourth year of tapping on the double-three system. These increased yields were obtained at the expense of a substantial scaling down of the girth increments compared with the trees tapped at a 100 per cent intensity.

There are, therefore, strong indications that young moderately high yielding rubber can give increased yields much above the theoretical increase in tapping intensity of 33 per cent of the double-three system, 2S/2, d/3, 133%.

The use of the double-three system of tapping for increased yields on young high yielding clones, even as an expedient for tiding over a temporary financial embarrassment, would be an extremely short-sighted policy; such increased yields are taken at the expense of growth, when good growth is an essential necessity in the case of young rubber. In the early years of maturity there must be a judicious compromise between yield output and growth requirements.

On estates where the losses of tapping days due to very high rainfall are excessive, it may be feasible to tap moderately high yielding rubber of 18 to 20 years of age on 2S/2, d/3, 133%. In such instances rigid stipulations are made for no extra tappings in the afternoons to make up for lost tapping days. It is hoped that in doing so the increased "actual" intensity of the double-three tapping system would not exceed the intensity of the S/2, d/2, 100% tapping system by more than 14 to 15 per cent. A loss of about 40 tapping days a year will reduce the double-three tapping system to an "actual" intensity of about 114 per cent.

The adoption of the double-three system with Sunday rest and with a more normal number of tapping days will also reduce the relative intensity of 133% of

the double-three system to an "actual" intensity of about 114% on any particular estate.

The double-four tapping system, 2S/2, d/4, 100%, can be used on budded rubber about the 4th tapping year, when the susceptibility to Brown Bast of particular clones has been checked. Increased yields of 12 to 20 per cent can be expected at a reduced tapping cost of about 16 per cent compared with the standard single-cut system tapped on alternate days, S/2, d/2, 100%. This system cannot be used on estates where a reduction in the number of tappers is not possible. The double-four tapping system is not suitable for rubber areas of under 100 inches rainfall per annum.

It is necessary to follow the change-over system of tapping recommended in our Advisory Circular No. 40 for introducing a double-cut tapping system any time after the third year of tapping.

C. A. De S.

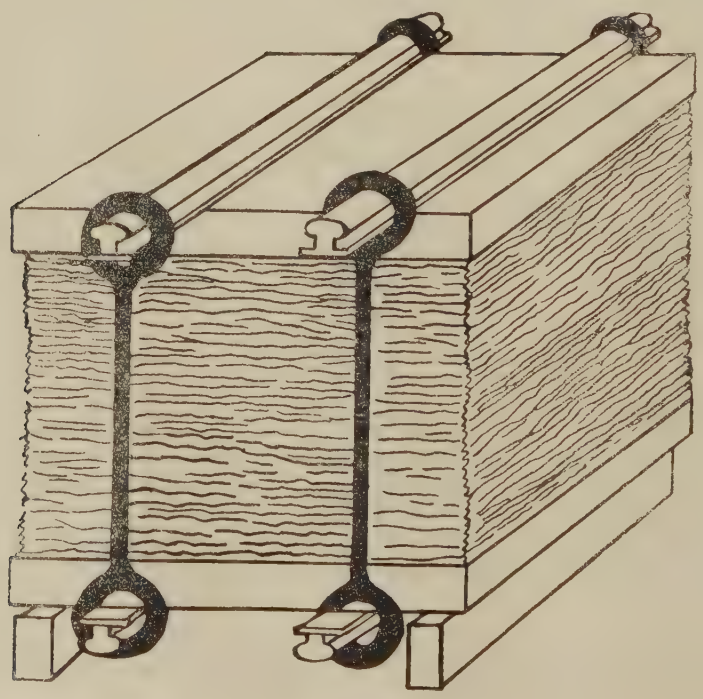
QUESTION CORNER

Question: Our bales of sheet rubber get badly deformed after a short period of storage which makes it difficult to stow them into proper stacks. We have also received complaints to this effect from our overseas customers. What steps could be taken to improve this defect?

Answer: It is well known that sheet rubber bales are often considerably deformed during storage and transport. Such bales are rather difficult to handle during unloading in the factories, because they are often troublesome on the conveyer belts, require more storage space, cannot be handled with fork lifts and do not fit the bale cutters. Very often they get distorted in the holds of ships into compact masses weighing up to some tons and have to be torn loose or cut, thereby resulting in the shipping marks becoming obliterated. It should be understood that all this will cause an increase in costs and other difficulties at assortment.

During storage and transport the rubber bales pick up dirt on their surfaces. If the bales retain their original shape, the coating will be a form of protection and the foreign impurities could be readily removed by brushing or by cutting away the wrappers. If the bales are badly deformed or stuck together in a coherent mass, cleaning them is practically impossible.

Besides factors such as the plasticity of the sheets and the procedure of manufacture, this deformation depends to a large extent upon the method of baling the rubber sheets, *i. e.* the pressure applied during the process of baling and the duration of pressing. Sheet bales should therefore be pressed by applying a pressure of at least 5 kg/cm_2, *i.e.* about 15 tons, on the surface of the bale. It is necessary to apply this pressure for a period as long as 12-24 hours and not for a few minutes only. For this purpose the pile of smoked sheet (without the wrappers) should be placed under the press between two heavy wooden pressing plates, each fitted with two iron bars or rail iron and clamped together after pressing. After 12-24 hours the clamps are released and the bale can be wrapped up and finished. A type of press which has given excellent results is shown in the following diagram:—



When stowing the bales they should be stacked on their surfaces and never on their sides. The height of a stacking should not exceed six bales and one inch thick planks dusted with talc should be placed between the layers of bales of each stacking.

For crepe rubber bales these precautions are not necessary because they are not very susceptible to deformation.

K. F. H.

Question: What are the precautions that have to be taken when storing dusting sulphur?

Answer: The problem of the storage of sulphur is a matter of concern to many planters, due to excess stocks of sulphur in hand following the mild Oidium seasons experienced during the last few years.

The primary precautions to be taken when storing sulphur are to provide good ventilation and to isolate this material from chlorates, nitrates and other oxidizing materials.

The bags of sulphur should not be dumped haphazardly in the stores. They should be stacked in neat rows allowing for adequate air circulation. In this connexion, it is also advisable to keep the doors and windows of the sulphur store-house open for a few hours on exceptionally hot days.

Bags of sulphur should never be dragged along the floor of the store-house; they should be lifted off the floor and carried to their destination. Friction of the sulphur particles against various inorganic materials can cause a fire. The fire hazard is significantly increased if the store-house had been used earlier for storing inorganic manures or other fungicides.

The sulphur should not be allowed to get damp as this could lead to spontaneous combustion.

It is best to store sulphur in a dry room, keeping it away from inorganic manures, empty manure bags, oily rags and any kind of resinous material.

As a general rule it is always preferable to store different fungicides in separate rooms; because in addition to the factors discussed above, stickers and wetting agents, incorporated in many new fungicides, may be incompatible and therefore may deteriorate in contact with other chemicals.

O. S. P.

The Rubber Research Institute of Ceylon

Minutes of the 160th meeting of the Rubber Research Board held at 10 a.m., on Friday, 27th February, 1959, in the Board Room of the Rubber Control Department, Eastern Bank Building, Fort, Colombo.

Present.—Mr. S. Pathmanathan (in the Chair) Mr. G. H. Carter, Dr. M. F. Chandraratne (Director of Agriculture), Mr. H. Creighton, Mr. L. C. de Mel, Mr. W. P. H. Dias J.P., Mr. V. T. G. Karunaratne M.P., Senator E. W. Kannangara O.B.E., Mr. H. E. Peries (Deputy Secretary to the Treasury), Dr. E. D. C. Baptiste (Director) and Mr. C. D. de Fonseka (Administrative Secretary).

An apology for absence was received from Mr. B. Mahadeva (Rubber Controller).

1. Minutes :

(*a*) *Confirmation.*—Draft minutes of the meeting held on 17th December, 1958, which had been circulated to the members, were signed by the Chairman.

(*b*) *Matters arising from the minutes—Augmentation of Water Supply.*—Implementation of the scheme recommended by the architects for immediate augmentation of the water supply at Dartonfield was authorised and a supplementary vote was passed for the purpose.

2. Administrative Committee :

The recommendations made by the Administrative Committee at its meeting held on 13th February, 1959, were approved as follows :—

(*a*) *Purchase of Sub-station.*—Agreed that the Hon'ble Minister of Agriculture and Food be requested to acquire on behalf of the Board an area of 200 acres out of two estates close to Avissawella which had been reported to be suitable for the purpose of establishing a sub-station.

(*b*) *Estate Superintendent's Reports for October and November* 1958—were approved.

(*c*) *Estate Accounts September to November* 1958—were approved.

(*d*) *Visiting Agent's Report on Dartonfield Group*—was approved.

(*e*) *End-of-contract leave of Director, Administrative Secretary and Estate Superintendent*—The proposed arrangements regarding the end-of-contract leave of these three officers were noted and acting arrangements to carry out the work during their absence were made.

(*f*) *Research Assistant, Chemistry Department*—The recommendation that the scholarship period of Mr. M. Nadarajah, Research Assistant, be extended until the end of May, 1959, was approved.

(*g*) *Swabhasa*—The recommendation that an endeavour be made to adopt the Government practice of using Swabhasa in the conduct of the Institute's affairs, as far as possible, was approved.

(*h*) *Director's visit to Vietnam and Cambodia*—The recommendation that the Director should visit the Rubber Research Institutes of Vietnam and Cambodia, when he goes on end-of-contract leave in April, 1959, was approved.

3. Staff :

(*a*) *Changes*—Changes in staff since the last meeting were reported and approved.

(*b*) *Loans to Officers for purchase of transport*—Loans given to six officers for the purchase of transport were reported and approved.

4. Publications :

The following publications were tabled :

1. Combined 3rd and 4th Quarterly Circulars for 1958.
2. Advisory Circular No. 61—Prevention of Coagulation in the Field.
3. ,, ,, No. 62—The White Root Disease of Hevea Fomes Lignosus.

Referring to the article by Dr. McIndoe published in the last issue of the Quarterly Circular, the Board approved the publication of similar articles of outstanding scientific interest to the rubber plantation industry.

5. Next meeting :

It was decided that the next meeting of the Board be held in Colombo at 9.30 a.m., on Wednesday, 25th March, 1959, preceded by an Administrative Committee meeting to be held at 9.30 a.m., on Friday, 13th March, 1959.

6. Any other business:

(*a*) *State-aided Sulphur-Dusting Scheme for Smallholders*—The Chairman reported the receipt of an interim report from the Smallholdings Advisory Officer on the progress made in the Sulphur-Dusting Scheme 1959. The final report would be put up to the Board for consideration in due course.

(*b*) *London Advisory Committee*—In view of a further increase in the estimated expenditure of the London Advisory Committee for 1959, consequent on increase of salaries of the staff, the Board's contribution for the year was increased.

(*c*) *Manuring*—It was reported that the Institute's general manuring recommendations had been revised recently and that an Advisory Circular embodying the revised recommendations would be issued very shortly.

(*d*) *Invitation from Milk Board*—An invitation from the Milk Board to the opening of its processing centre on 1st March, 1959, was tabled.

The meeting then terminated.

The Rubber Research Institute of Ceylon

Minutes of the 161st meeting of the Rubber Research Board held at 9.30 a.m., on Wednesday, 25th March, 1959, in the Board Room of the Rubber Control Department, Eastern Bank Building, Fort, Colombo.

Present.—Mr. S. Pathmanathan (in the Chair), Mr. G. H. Carter, Dr. M. F. Chandraratne (Director of Agriculture), Mr. L. C. de Mel, Mr. W. P. H. Dias J.P., Mr. V. T. G. Karunaratne M.P., Dr. E. D. C. Baptiste (Director) and Mr. C. D. de Fonseka (Administrative Secretary).

Apologies for absence were received from Mr. H. E. Peries (Deputy Secretary to the Treasury) and Mr. H. Creighton.

1. Minutes :

(*a*) *Confirmation*—Draft minutes of the meeting held on 27th February, 1959, which had been circulated to members, were signed by the Chairman.

2. Administrative Committee :

The recommendations made by the Committee at its meeting held on 13th March, 1959, were approved and the following decisions were arrived at on the basis of these recommendations :

(*a*) *Chairman's and Director's Reports for* 1958—were approved and the following points were noted with interest :

1. *Yields of RRIC Clones established from hand-pollinated seedlings*—Very satisfactory yields had been obtained from these clones.

2. *Tapping experiments.*—Three experiments had been initiated to study the economics of increased yields from high tapping on virgin bark of low yielding old budded rubber, with and without the application of yield stimulants.

3. *Manuring.*—A new circular giving more comprehensive advice on manure mixtures to be used in different districts would be issued shortly.

4. *Control of Bark Rot.*—The use of Antimucin, an organo-mercuric compound, for the efficient control of Bark Rot.

(*b*) *Estate Superintendent's Report for December* 1958—was approved and the recommendation that the quantity of rubber in store at the end of each month should be shown in the monthly accounts as well as in the monthly reports was accepted.

(*c*) *Visiting Engineer's Report*—was approved.

3. Salaries Committee :

The recommendations made by the Committee at its meeting held on 24th March regarding salary conversion and payment of overtime to staff were approved.

4. Building Committee :

The recommendations made by the Committee at its meeting held on 13th and 24th March, 1959, were approved and contracts for the construction of the following buildings were awarded :

(*a*) Superintendent's Office at Hedigalla.
(*b*) Double Cottage for Minor Staff at Dartonfield.
(*c*) Two Single Cottages for Minor Staff.
(*d*) Extension to Club House at Dartonfield.
(*e*) Estate Superintendent's Bungalow.
(*f*) Three Double Cottages for Estate Labourers.

The procedure to be adopted in connexion with future building work was settled.

5. Reports and Accounts :

Receipts and Payments Account for the 4th Quarter 1958 was approved and it was noted that provision had been made for the appointment of a further Research Assistant in each department in 1959.

6. Staff :

(*a*) *Administrative Secretary.*—Mr. C. D. de Fonseka, Administrative Secretary, was re-engaged for a further period of 3 years and 3 months as Chief Administrative Officer.

(*b*) *Assistant Plant Pathologist.*—Arrangements made for Mr. O. S. Peries, Assistant Plant Pathologist, to undergo a course of training in U.K. were noted.

(*c*) *Assistant and Minor Staff Changes.*—Changes in staff since the last meeting were reported and approved.

7. Next meeting :

It was decided that the next meeting of the Board be held in Colombo at 9.30 a.m., on Friday, 22nd May, 1959.

8. Any other business :

(*a*) *Publications.*—Agreed that the Quarterly Circular be re-designated Quarterly Journal. New covers for the Quarterly Journal and Annual Report were tabled and approved.

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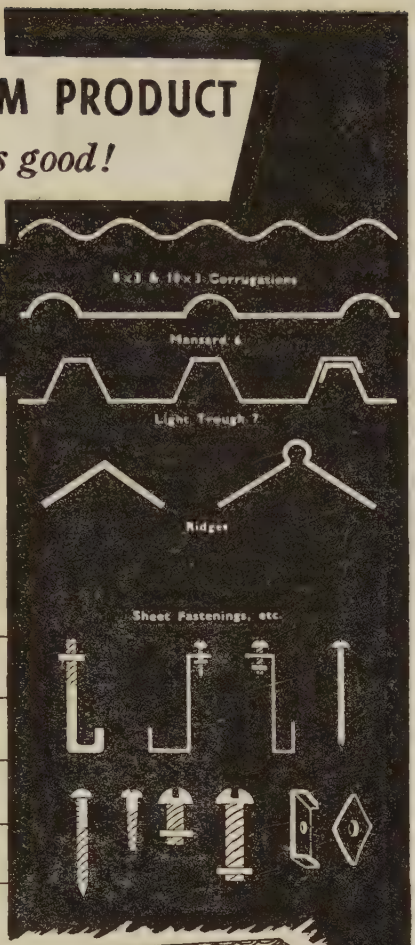

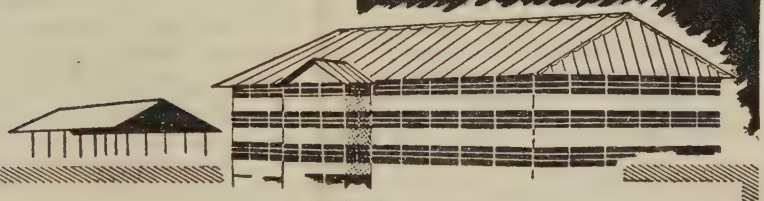

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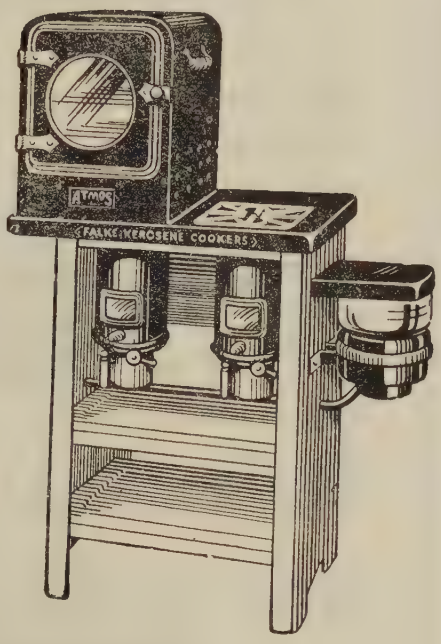

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- Each burner consumes—
  Full power ½ pint per hour per burner

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  For General cooking, burners never require being used to their full, and economy is thereby effected.

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No. 33 THREE BURNERS
No. 34 FOUR BURNERS

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No. 23 COVERING ONE BURNER
No. 24 COVERING TWO BURNERS

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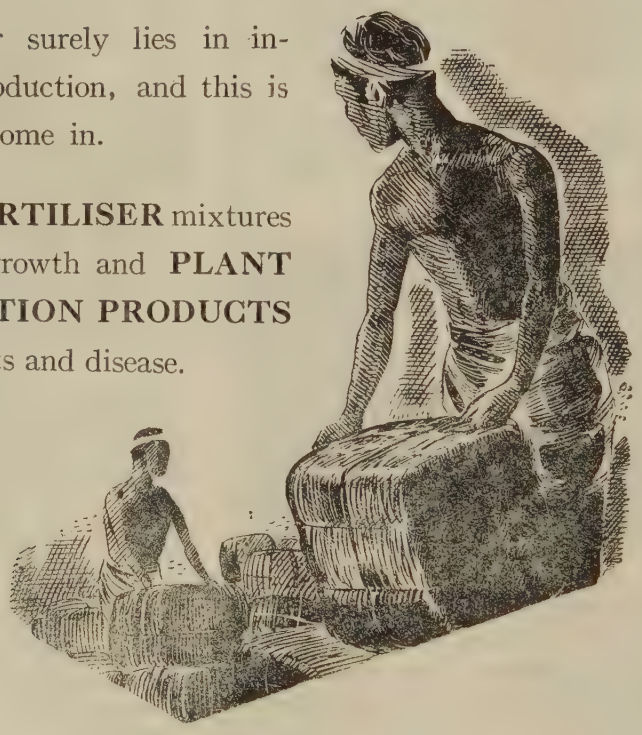

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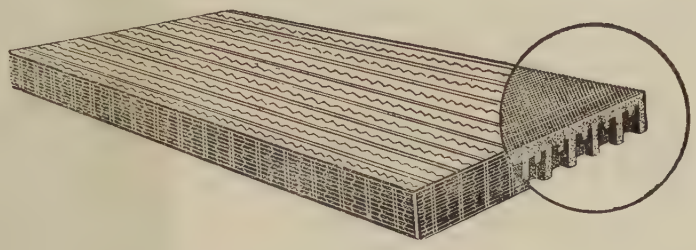

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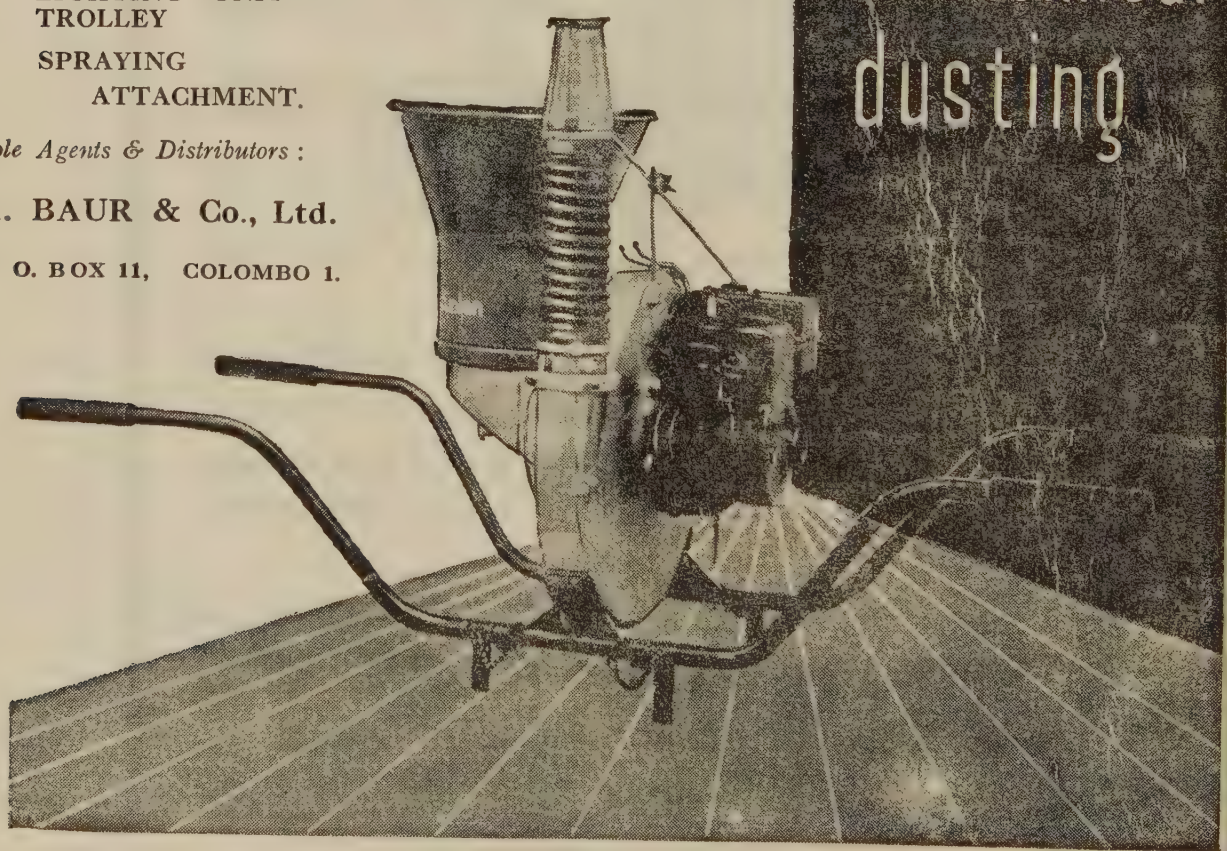

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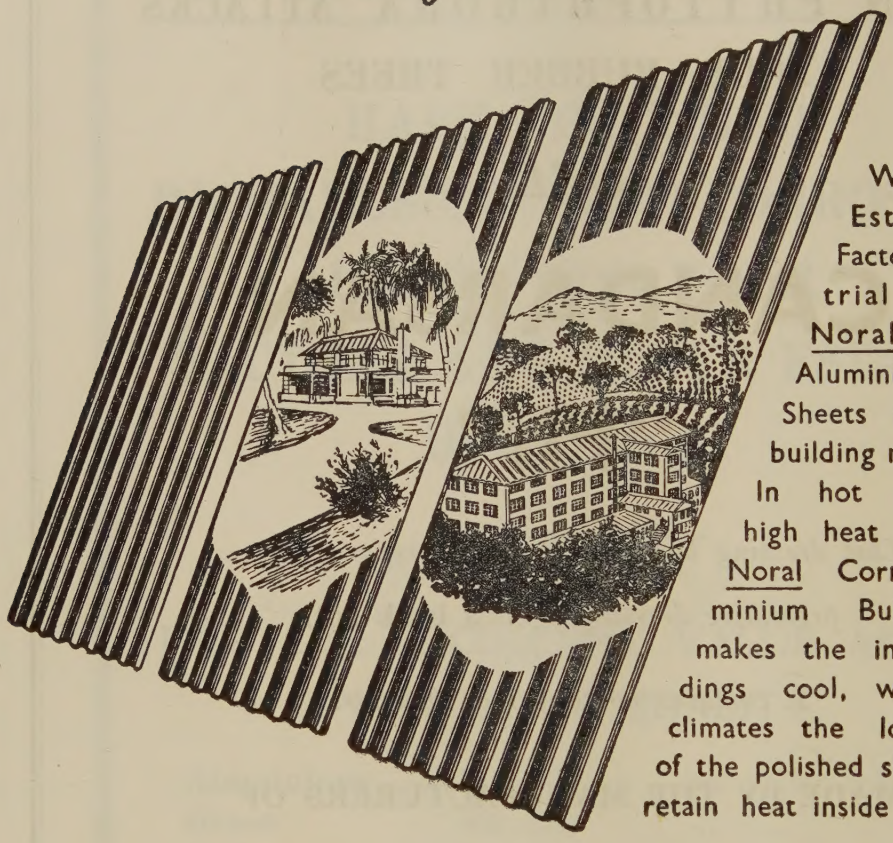

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26 ,, ,, nine 2.2/3″ ,,
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Thicknesses : 20, 22, 23, 24 and 26 Imperial Standard Wire Gauge.
The 32″x24 SWG sheets with 10/3″ corrugations are available from stock in 6, 7, 8, 9 and 10 feet sizes.

AUX 14